

November 20, 1995

F/AKC1:DRM

**PRELIMINARY CRUISE RESULTS  
NOAA SHIP MILLER FREEMAN  
CRUISE NO. 95-10**

**ECHO INTEGRATION-TRAWL SURVEY  
OF PACIFIC WHITING ALONG THE WEST COASTS OF  
THE UNITED STATES AND CANADA**

**CRUISE PERIOD, AREA, AND SCHEDULE**

Scientists from the Alaska Fisheries Science Center (AFSC) conducted a West Coast echo integration-trawl (EIT) survey of Pacific whiting (Merluccius productus) aboard the NOAA ship Miller Freeman from July 1 to September 1, 1995, for a total of 60 sea days. The cruise began in Seattle, Washington and ended in Ketchikan, Alaska. Exploratory survey operations were also conducted within the northern portion of the Southern California Bight (32°30'N to 34°30'N). Thereafter the vessel progressed northward conducting survey operations over the continental shelf and upper slope from near Point Conception (34°30'N) to Dixon Entrance (54°30'N). The areas of operation in Canadian waters were the west coasts of Vancouver and Queen Charlotte Islands. The major objective of this survey was to collect echo integration and trawl data necessary to determine the distribution and abundance of Pacific whiting.

**VESSEL ITINERARY**

Leg 1

|          |   |
|----------|---|
| July 1-3 | Embark portion of scientific party in Seattle; conduct gear trials in Puget Sound; sphere calibration in Port Susan |
| July 3   | Begin transit south to area for juvenile Pacific whiting exploratory survey operations near Point Conception        |
| July 6   | Monterey touch-and-go to embark portion of scientific party   |
| July 6-7 | Begin juvenile Pacific whiting exploratory survey operations near Point Conception                                  |

July 8 Sphere calibration in Channel Islands

July 11 Finish exploratory survey operations, begin West Coast EIT survey of Pacific whiting

July 12 Monterey touch-and-go to disembark portion of scientific party

July 18 In port at San Francisco; exchange of scientific personnel; end Leg 1

#### Leg 2

July 20 Continue West Coast EIT survey of Pacific whiting

Aug 9 In port at Grays Harbor; exchange of scientific personnel; end Leg 2

#### Leg 3

Aug 12 Continue West Coast EIT survey of Pacific whiting

Aug 16 Neah Bay touch-and-go to disembark member of scientific party

Aug 17 Neah Bay touch-and-go to embark member of scientific party

Aug 19-20 Intership calibration of scientific acoustic systems with the Canadian research vessel W.E. Ricker

Aug 21 Sphere calibration in Kendrick Inlet, Vancouver Island; exchange of scientific personnel

Sept 1 In port at Ketchikan; end of cruise

### **OBJECTIVES**

The principal objectives of the cruise were to:

- 1) collect echo integration data, and midwater and demersal trawl data necessary to determine the distribution, biomass, and biological composition of Pacific whiting in the area of operations;
- 2) collect Pacific whiting target strength data for use in refining relationship between target strength and fish length;

- 3) collect echo integration data, and midwater trawl data necessary to determine the distributional patterns and biological characteristics of the common macrozooplankton species (e.g., euphausiids) in the area of operations;
- 4) calibrate the centerboard-mounted 38/120 kHz scientific acoustic system using standard sphere techniques;
- 5) conduct an intership calibration with the Canadian research vessel W.E. Ricker;
- 6) collect various meteorological and physical oceanographic data including vertical profiles of temperature and salinity at selected sites, and continuous monitoring of near-surface currents, temperature, salinity, etc;
- 7) collect stomach samples from Pacific whiting for food habits studies;
- 8) conduct an exploratory survey to collect echo integrator and midwater trawl data necessary to determine the feasibility of using acoustic methods to assess the distribution and biomass of juvenile Pacific whiting; and,
- 9) conduct gear trials with an experimental survey bottom trawl.

#### **VESSEL AND SCIENTIFIC EQUIPMENT**

The survey was conducted on board the NOAA ship Miller Freeman, a 66-m (216-ft) stern trawler equipped for fisheries and oceanographic research. Acoustic data were collected with a quantitative echo-sounding system (Simrad EK500<sup>1</sup>). The Simrad 38 and 120 kHz split-beam transducers were mounted on the bottom of the vessel's centerboard. Results presented in this document are based on the 38 kHz data. With the centerboard fully extended, the transducers were 9 m below the water surface. System electronics were housed in a portable laboratory mounted on the vessel's weather deck. Data from the Simrad EK500 echo sounder were stored and processed using the Simrad BI500 echo-integration and target-strength data collection and analysis software on a SUN workstation.

Six different gear types were used during the cruise and are described below. During the exploratory survey (see Survey Methods), an Aleutian Wing 30/60 trawl (AWT) and a modified Stauffer

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<sup>1</sup> Reference to trade names or commercial firms does not constitute U.S. Government endorsement.

trawl (anchovy trawl) were used to sample midwater echosign. During the west coast EIT of Pacific whiting (see Survey Methods), midwater echosign was generally sampled with the AWT, although several tows were made with a Methot or Marinovich trawl when scattering from smaller organisms was suspected. Bottom echosign was primarily sampled with a nylon Nor'eastern trawl during the EIT survey. On three occasions, a modified poly Nor'eastern (PNE) trawl was also used. The primary purpose of the PNE trawl during the cruise was to evaluate its fishing performance over various bottom types (see Survey Methods).

The Aleutian Wing 30/60 trawl is a full mesh wing trawl constructed of nylon except for Polyethelene towards the aft section of the body and the codend. The head- and footrope measured 816.9 m (268 ft) and mesh sizes tapered from 325.1 cm (128 in) in the forward section of the net to 8.9 cm (3.5 in) in the codend. The net was fitted with a 3.2 cm (1.25 in) codend liner. The codend was also fitted with a 0.48 cm (0.19 in) codend liner during the exploratory survey and the first nine midwater hauls north of Pt. Conception. The AWT was fished with 82.4 m (270 ft) of 1.9 cm (0.75 in) diameter 8x19 non-rotational dandyline, 454.5 kg (1,000-lb) tom weights on each side, and either 1.8 m x 2.7 m (6-ft x 9-ft) steel V-doors [1,000 kg (2,200 lb)] or 5 m<sup>2</sup> "Fishbuster" doors [1,250 kg (2,750 lb)].

The Marinovich, Methot, and modified Stauffer trawls targeted juvenile fish and macrozooplankton in midwater. The Marinovich trawl mesh sizes measured 7.6 cm (3.0 in) forward, 3.2 cm (1.3 in) in the codend, and 0.32 cm (0.125 in) in the codend liner. Headrope and footrope lengths were each 9.1 m (30 ft). The Marinovich trawl was fished with the 1.8 m x 2.7 m steel V-doors. The Methot trawl has a rigid square frame with 2.3 m (89.5 in) sides which forms the mouth of the net. A 1.83-m (6 ft) dihedral depressor modified from an Isaacs-Kidd midwater trawl was suspended from the square frame. Mesh sizes were 2 mm x 3 mm (0.08 in x 0.12 in) in the main part of the net and 1 mm (0.04 in) in the codend. The Methot trawl was attached to a single cable that was fed through a stern-mounted A-frame. A calibrated General Oceanics flow meter was attached to the mouth of the net and used to determine the volume of water filtered. The modified Stauffer trawl was used on two occasions during the exploratory survey. This net is designed with an overall length of about 47 m (154.2 ft) and a square mouth with 26.2 m (86 ft) on a side. The mesh size decreased from 15.2 cm (6 in) in the body to 3.8 cm (1.5 in) in the codend. The codend was also fitted with a 0.48 cm (0.19 in) codend liner. The modified Stauffer trawl was fished with triple 54.9 m (180 ft) bridles and 1.5 m x 2.1 m (5-ft x 7-ft) steel doors.

Fish on or near bottom were primarily sampled with a nylon Nor'eastern (NNE) bottom trawl during the EIT survey. Mesh sizes ranged from 12.7 cm (5 in) in the body to 8.9 cm (3.5 in) in the intermediate section and codend. The net was fitted with a 3.2 cm

(1.25 in) codend liner. Headrope and footrope lengths were 27.4 m and 32.0 m (90 ft and 105 ft), respectively, and the footrope was equipped with 36 cm (14 in) diameter roller gear. The NNE was fished with triple 54.8 m (180 ft) long dandy lines and the 5 m<sup>2</sup> "Fishbuster" doors. The experimental poly Nor'eastern bottom trawl (described below) was used once with the 1.8 m x 2.7 m steel V-doors and twice with the 5 m<sup>2</sup> "Fishbuster" doors during the EIT survey.

A poly Nor'eastern high-opening bottom trawl was used in the gear evaluation study during the third leg of the cruise. For the gear experiment, this trawl was equipped with tire/rockhopper ground gear. The trawl was constructed with stretch mesh sizes that ranged from 13 cm (5 in) in the forward portion of the net to 8.9 cm (3.5 in) in the codend. It was fitted with a nylon codend liner with a mesh size of 3.2 cm (1.25 in). The 27.2-m (89.1-ft) headrope held 21 floats [30 cm (12 in) diameter]. A 24.7-m (81-ft) chain fishing line was attached to the 24.9-m (81.6-ft) footrope which was constructed of 1-cm (0.4-in) 6 x 19 wire rope wrapped with polypropylene rope. The ground gear consisted of 50.8 cm (20 in) split tires in the bosom of the trawl and fitted with 45.7 cm (18 in) rockhopper discs and steel bobbins along the wings. The trawl was fished with the 1.8 m x 2.7 m steel V-doors except on one occasion when it was fished with the 5 m<sup>2</sup> "Fishbuster" doors. The modified ground gear configuration was designed to better sample the rugged areas of the continental slope and thus represented a significant departure from the 35.6 cm (14 in) rubber bobbin roller gear normally used during triennial groundfish surveys of the Gulf of Alaska and West Coast. The characteristics of the experimental trawl were monitored during the fishing process with a Scanmar net mensuration system and a Hi-8 mm video camera assembly.

All trawl hauls, except the Methot, were monitored with a WesMar third wire or a Furuno wireless net sounder system attached to the headrope of the trawl; vertical net opening, depth, and temperature at depth were measured. The AWT and NNE vertical mouth opening averaged 26.6 m (87.3 ft) and 5.8 m (19 ft), respectively.

Vertical profile measurements of water temperature and salinity were collected with a Seabird CTD (conductivity/temperature/depth) system. Temperature and depth profile data were collected during trawl hauls by attaching a micro bathythermograph (MBT; a small, retrievable depth/temperature profiler) to the trawl headropes or frame. Expendable bathythermographs (XBT) were used at several sites. The acoustic Doppler current profiler was slaved to the EK500 to avoid interference and operated continuously throughout the cruise.

## SURVEY METHODS

Scientific operations were conducted 24 hours per day. Echo integration data to determine the abundance and distribution of Pacific whiting were collected continuously during daylight hours (about 15 hours per day) along a series of parallel (and 3 zig-zag) transects between Point Conception and Dixon Entrance (Fig. 1). Transects were spaced about 10 nmi apart except inshore near the US-Canada border where transect spacing was reduced to 5 nmi and off the Queen Charlotte Islands where it was increased to 15 nmi. During the exploratory survey of juvenile Pacific whiting which occurred in the vicinity of Pt. Conception (between 32° 30'N and 34° 30'N), echo integration data were collected along a series of zig-zag transects during daylight and darkness (Fig. 1a).

All transects were generally run between about the 55 m and 1500 m depth contours. Transects were extended to deeper water where fish sign was found at or near the predetermined transect outer endpoints. Acoustic data were generally collected to within 0.5 m of the bottom, depending upon bottom depth and roughness. Transect speed was usually around 11-12 knots.

Nighttime hours were used on an opportunistic basis to collect Pacific whiting target strength data, conduct trawl hauls on echosign observed during the daytime survey operations or to investigate aggregations of other midwater fishes and macro-zooplankton. Nighttime gear trials with an experimental survey trawl were also carried out over various habitat types and depth zones during leg 3.

Trawl hauls were made on selected echo sign to provide information on Pacific whiting and to identify the biological composition of associated fish and other organisms. Standard catch sorting and enumeration procedures were used to process all catches. Each trawl catch was completely sorted unless it exceeded about 900 kg, catches greater than 900 kg were split and the split then sorted and weighed. Total weights and numbers of individuals, by species, were determined for each catch. Pacific whiting were further sampled to determine sex, length (standard length (SL) for fish <80 mm, fork length (FL) for fish >80 mm), gonad weight, age, maturity, and body weight. Stomach samples were also collected from Pacific whiting and preserved in 10% formalin. An electronic scale was used to determine all weights taken from individual whiting specimens. Fish FLs were determined to the nearest cm with a Polycorder measuring device (a combination of a bar code reader and a hand held computer), and fish SLs were determined to the nearest mm using a measuring board.

Generally, CTD casts were made at selected trawl haul locations, and at two to three stations along every second or third transect (i.e., every 0.2°-0.5° latitude) during the survey (Fig. 3). One station was located at the offshore end of the transect and the second was located over a nominal bottom depth of 400 m along the same

transect. A third CTD cast was sometimes made between these two CTD stations.

### Standard Sphere Calibrations

Standard sphere calibrations were conducted on the 38 kHz and 120 kHz acoustic systems (Table 1). The Miller Freeman was anchored fore and aft during the Port Susan and Kendrick Inlet calibrations and not anchored during the Santa Cruz Island calibration. Acoustic returns of a 23 mm diameter (for 120 kHz) and 60 mm (for 38 kHz) copper sphere suspended below the transducer were measured. Split-beam target strength and echo-integration data were collected with the Simrad EK500 system to describe acoustic gain parameters and/or transducer beam pattern characteristics. During the Santa Cruz Island calibration, only on-axis target strength measurements at 120 kHz were collected. The 120 kHz acoustic system exhibited a negative trend in target strength (TS) and volume backscattering (SV) gains with time, while the 38 kHz system remained stable (Table 1).

## **PRELIMINARY RESULTS**

A total of about 3800 nmi of transect lines were run during the west coast EIT survey to assess the distribution and abundance of Pacific whiting (Fig. 1). Ninety-five trawl hauls were made to identify echo sign in this region and to collect specimen and biological data (Fig. 1). Twenty-six Methot trawls were conducted on echo sign believed to be primarily macrozooplankton (Fig. 2). Details regarding trawl locations, depths, and catch are presented in Tables 2 and 3. Biological collections are summarized in Table 4.

Pacific whiting was the dominant fish species captured in the midwater trawl hauls by weight and by numbers, and ranked first in weight among fishes captured in bottom trawl hauls (Tables 5-6). Yellowtail rockfish (Sebastes flavidus) and shortbelly rockfish (Sebastes jordani) were the next most common species caught, by weight, in midwater and bottom trawl hauls, respectively. Young of the year Pacific whiting (2-8 cm FL) were only caught in five trawl hauls (hauls 1-3, 5-6) in the southern California region (34°55'-40°30'N). Except for haul 5, YOY were captured with older whiting.

Physical oceanographic data were collected at all locations where a trawl haul was made as well as at other selected sites. The measurements consisted of 78 CTD, 4 XBT, and 141 MBT casts. Details pertaining to these casts (time, location, associated trawl hauls, etc.) are listed in Tables 7-9. Figure 3 shows the locations of the CTD and XBT casts.

### The distribution, size and relative abundance of Pacific whiting

Relatively dense Pacific whiting echosign was observed off California near Point Arena and Cape Menocino, off central Oregon (43-45°N), over Juan de Fuca Canyon near Cape Flattery, and off northern Vancouver Island (Fig. 4). No echosign was attributed to Pacific whiting north of 51°N or south of about 38°N. Although Pacific whiting were sometimes caught south of 38°N, scattering from other species was so prevalent that it prevented identification of Pacific whiting echosign from this area. Pacific whiting were observed over bottom depths of 50-1500 m.

The size composition of Pacific whiting differed over the survey area (Fig. 5). Fish comprising the 20-30 cm mode (primarily 1-year olds) were present in the southern California area, strongly represented in the north California area (40°30'-43°00'N), moderate in Oregon (43°00'-45°46'N), and present in relatively low numbers in the northern areas (i.e., Washington (45°46'N to the US/Canada border), south Vancouver (the US/Canada border to 49°00'N), and north Vancouver (49°00' to 51°03'N)). The distribution of one year old fish extended farther to the north than that reported from previous EIT surveys. Fish comprising the 30-40 cm length mode (primarily 2-year olds) were strongly represented in the California areas and nearly absent in the northern areas. Adult fish (>40 cm) were present throughout the survey area, although their contribution was minimal in the southern California area. Generally, the modal length of adult fish increased to the north. The dominant mode was 45 cm in the Oregon area and increased to 48 cm in the north Vancouver area.

### Exploratory Survey of Juvenile Pacific Whiting

Approximately 730 nmi of transect lines (Fig. 1a) were completed during the exploratory survey of juvenile Pacific whiting. Twelve trawl hauls were completed (Fig. 1a) and are summarized in Table 10. Further results will be reported elsewhere (A. Hollowed, National Marine Fisheries Service, Seattle, WA 98115. Pers. commun.).

### Experimental Bottom Trawl Gear Trials

A total of twenty-seven bottom trawl hauls (Fig. 6 and Table 11) were completed over a variety of habitat types and depth zones during gear trials with the experimental survey bottom trawl. Nineteen hauls were completed with the codend opened (hauls 201, 203-219 and 223) and eight were completed with the codend closed (202, 220-227 except 223). Open codend tows were conducted to establish the preferable camera placements for viewing the various sections of the ground gear. Results from the closed codend tows



will allow a comparison between the number and species observed by the video camera versus what was actually retained by the trawl. Results will be reported elsewhere (D. Ito, National Marine Fisheries Service, Seattle, WA 98115. Pers. commun.).

#### Target Strength Data Collection

Target strength data were collected and nine hauls were made to verify the echosign on five different nights off the coast of northern Washington and Vancouver Island (Table 1). Pacific whiting produced unimodal size distributions from target strength hauls 71, 76, 80-81, and 84-85, and bimodal distributions from target strength hauls 65 and 66. Pacific whiting made up 93-99% of the catch in numbers from these hauls.

#### U.S. and Canadian acoustic systems comparison

An inter-ship comparison study of the scientific echosounding systems aboard the Miller Freeman and the Canadian research vessel, W.E. Ricker was conducted during 19-22 August. There were two acoustic systems aboard the Canadian vessel which operated at 38 kHz. Additional descriptions of these acoustic systems is reported elsewhere (R. Kieser, Pacific Biological Station, Department Fisheries and Oceans, Nanaimo, Pers. commun.). Acoustic data were collected along 24 east-west oriented transects in an area about 15 nmi NW of Cape Flattery (48°27.3'N, 125°9.3'W) and in an area near Nootka Sound (48°38.6'N, 125°58.7'W). Transects were 3-8 nm in length and over bottom depths between about 110-795 m. One vessel followed about 0.5 nm directly astern of the other along each transect. The vessel taking the lead position changed after each pair of transects. Vessel speeds were about 6-8 knots.

#### SCIENTIFIC PERSONNEL

| Name            | Sex/<br>Nationality | Position           | Organization | Dates<br>Aboard |
|-----------------|---------------------|--------------------|--------------|-----------------|
| <u>Leg 1</u>    |                     |                    |              |                 |
| Chris Wilson    | M/USA               | Chief Scientist    | AFSC         | July 1-July 18  |
| Daniel Twohig   | M/USA               | Instrument Chief   | AFSC         | "    "-"    "   |
| Steve de Blois  | M/USA               | Fish. Biologist    | AFSC         | "    "-"    "   |
| Martin Dorn     | M/USA               | Fish. Biologist    | AFSC         | "    "-"    "   |
| Troy Buckley    | M/USA               | Fish. Biologist    | AFSC         | "    "-"    "   |
| Dave Fitzgerald | M/USA               | Teacher-At-Sea     | OLA          | "    "-"    "   |
| Andy Seitz      | M/USA               | Undergrad. Student | Cornell      | July 1-July 18  |
| Dave King       | M/USA               | Gear Technician    | AFSC         | July 1-July 12  |
| Dennis Benjamin | M/USA               | Fish. Biologist    | AFSC         | July 6-July 18  |
| Anne Hollowed   | F/USA               | Fish. Biologist    | AFSC         | July 6-July 12  |
| Bob DeLong      | M/USA               | Wildlife Biologist | NMML         | July 6-July 12  |

|           |            |                 |     |                |
|-----------|------------|-----------------|-----|----------------|
| Ken Cooke | M/Canadian | Fish. Biologist | DFO | July 6-July 12 |
|-----------|------------|-----------------|-----|----------------|

Leg 2

|                 |       |                  |      |               |
|-----------------|-------|------------------|------|---------------|
| Jim Traynor     | M/USA | Chief Scientist  | AFSC | July 20-Aug 9 |
| Dan Twohig      | M/USA | Instrument Chief | AFSC | "    "-"    " |
| Mike Guttormsen | M/USA | Fish. Biologist  | AFSC | "    "-"    " |
| Steve de Blois  | M/USA | Fish. Biologist  | AFSC | "    "-"    " |
| Denise McKelvey | F/USA | Fish. Biologist  | AFSC | "    "-"    " |
| Chris Derrah    | M/USA | Fish. Biologist  | AFSC | "    "-"    " |
| Paul von Szaly  | M/USA | Graduate Student | UW   | "    "-"    " |
| Susie Diessner  | F/USA | Teacher-At-Sea   | OLA  | "    "-"    " |
| Jeff Pesta      | M/USA | Teacher-At-Sea   | OLA  | July 20-Aug 9 |

Leg 3

|                  |       |                  |      |               |
|------------------|-------|------------------|------|---------------|
| Neal Williamson  | M/USA | Chief Scientist  | AFSC | Aug 12-Aug 16 |
| Jim Traynor      | M/USA | Chief Scientist  | AFSC | Aug 17-Aug 21 |
| Neal Williamson  | M/USA | Chief Scientist  | AFSC | Aug 21-Sept 1 |
| Daniel Twohig    | M/USA | Instrument Chief | AFSC | Aug 12-Sept 1 |
| Taina Honkalehto | F/USA | Fish. Biologist  | AFSC | "    "-"    " |
| Steve de Blois   | M/USA | Fish. Biologist  | AFSC | "    "-"    " |
| Dennis Benjamin  | M/USA | Fish. Biologist  | AFSC | "    "-"    " |
| Rich Wiggins     | M/USA | Fish. Biologist  | AFSC | "    "-"    " |
| Dan Ito          | M/USA | Fish. Biologist  | AFSC | "    "-"    " |
| Andrea Balla     | F/USA | Fish. Biologist  | NMML | "    "-"    " |
| Avis Sosa        | F/USA | Teacher-At-Sea   | OLA  | Aug 12-Sept 1 |
| Craig Rose       | M/USA | Fish. Biologist  | AFSC | Aug 12-Aug 21 |
| Ken Weinberg     | M/USA | Fish. Biologist  | AFSC | Aug 12-Aug 21 |
| Martin Dorn      | M/USA | Fish. Biologist  | AFSC | Aug 21-Sept 1 |

AFSC - Alaska Fisheries Science Center, Seattle, Washington

NMML - National Marine Mammal Laboratory, Seattle, Washington

OLA - NOAA, Office of Legislative Affairs, Teachers at Sea Program,  
Washington, D.C.

DFO - Dept. Fisheries and Oceans, Pacific Biological Station, Nanaimo, BC,  
Canada

UW - University of Washington, School of Fisheries, Seattle, Washington

Cornell - Cornell University, Ecosystems Research Center, Ithaca, New York

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For further information contact Dr. Gary Stauffer, Director, Resource Assessment and Conservation Engineering Division, Alaska Fisheries Science Center, National Marine Fisheries Service, 7600 Sand Point Way NE., Building 4, BIN C15700, Seattle, WA 98115-0070. Telephone (206) 526-4170.

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